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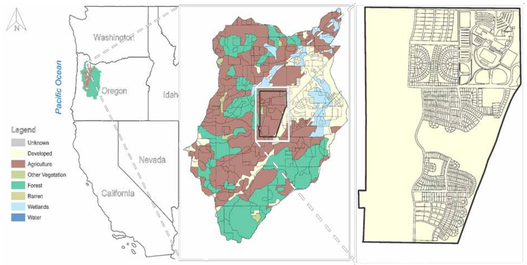


Maps illustrating multiple scales of the Oregon UWIN project (1) Willamette River basin, (2) Chicken Creek watershed, and (3) Sherwood Urban Reserve.

Scale	Area (ha)	Model	Indicators
Willamette River Basin	2,972,800	Envision	Water supply, demand vol.
Chicken Creek Watershed	4,150	OUWINvision; Species-Habitat	Min., Max flows Biodiversity
Sherwood UR	492	SWMM	Area of GI, peak flows

Title: Innovations in Urban Water Systems

Research Problem: To what extent can innovative water system design and management mitigate impacts of future change?

Methods: We used a stakeholder-guided process to develop three alternative future scenarios for the Willamette River Basin (WRB) that explore the effects of climate change, population growth, and human responses to these future challenges. Although the project focus is on impacts to water systems, we implemented scenario designs by envisioning landscape change across the WRB at three scales. The impacts of landscape change can thus be assessed for other systems. The scenarios combine two rates of climate and population change with three policy and management responses.

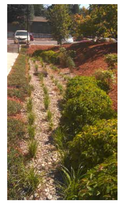
Drivers	Early Adopter (IWF)	Late-Adopter (CC)	Non-Adopter (SR)
Human Response	"One-water" integrated mgmt.	Current policies retained	Water infrastructure stressed
Climate	4.2°C increase in MAT; less snow	2.5 °C increase in MAT; less snow	4.2°C increase in MAT; less snow
Population	6.2 million	4.5 million	6.2 million

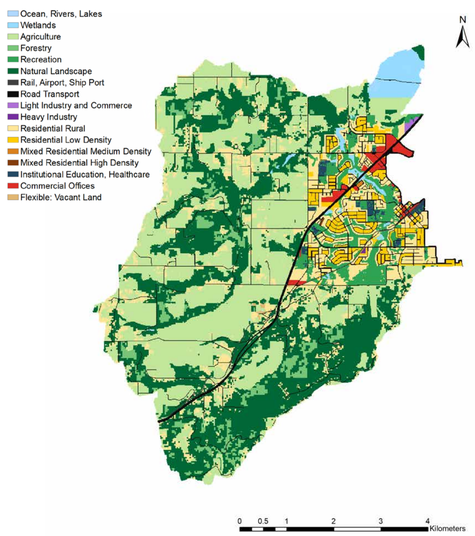
Requirements

- Population Growth: Population in Willamette River Basin (WRB) increases to between 4.5 million (in the Current Course future (CC)) and 6.2 million (in the Integrated Water (IWF) and Stressed Resources (SR) futures) by the decade 2050-2060.
- Urban development: In areas surrounding major cities in the WRB (such as the Chicken Creek watershed outside Portland), Urban Reserves undergo development
- Climate Change: Mean annual temperature increases across the WRB by 2.5 °C (CC) to 4.1 °C (IWF and SR). Precipitation both increases and becomes more variable, and snow storage declines
- Water Storage: New claims are made for stored water in WRB of up to 159,750 acre-feet for municipal uses, and up to 327,650 acre-feet for agricultural irrigation in in IWF and SR futures. No new water claims are made in CC future.
- Institutions: Policy responses to increasing rates of change are either forward-looking and anticipatory (IWF) and help mitigate the negative impacts of change, or lag behind impacts (CC and SR); in SR future, resources needed to address the impacts of rapid climate and population change consume substantial resources that would otherwise be available to prevent, mitigate, and adapt to changes.

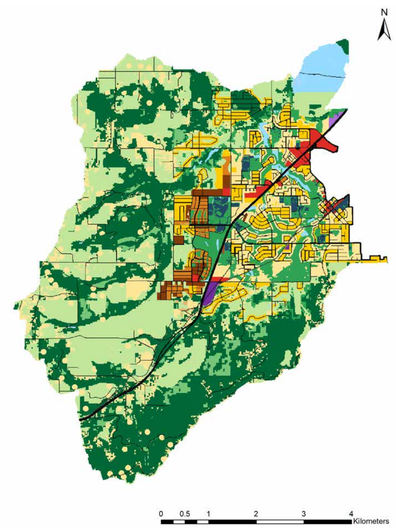
Innovations

1. AGR 2035/2050 [new] Forest fuel reduction
2. GRN 2035 [1] Resilient landscape infrastructure
3. GRN 2035/2050 [8] Ecosystem services of green infrastructure
4. GRN 2035/2050 [10] Green urban streets
5. GRN 2035 [13] Regaining the riparian ecosystem
6. INS 2035/2050 [new] Agencies and institutions collaborate more frequently and water sharing agreements more common
7. MIX 2035 [14] Sustainable neighborhood pattern and design
8. WAT 2035 [8] Bioretention
9. WAT 2035/2050 [3] Agricultural water conservation and best management practices
10. WAT 2035/2050 [new] Increased water reuse

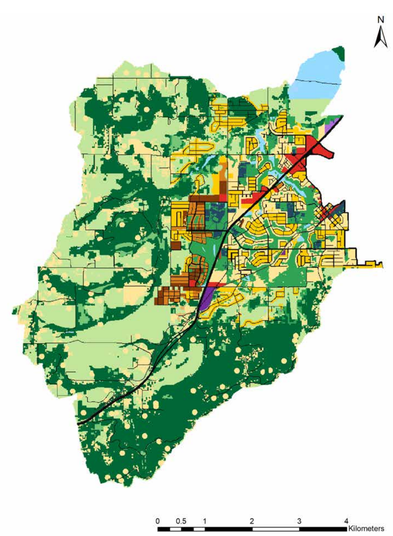




Existing situation: 2020



Early adopter: 2035



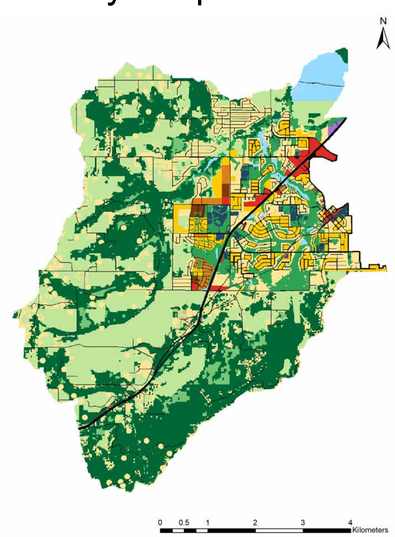
Early adopter: 2050

"One Water"

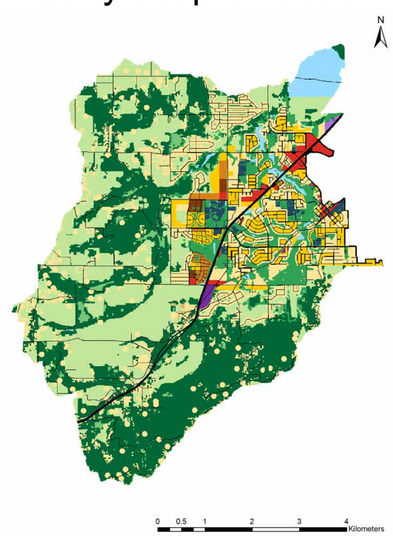
"One Water" approaches promote integrating water management across drinking water, wastewater, stormwater and natural hydrologic systems. "One water goals" include the following:

- Provide reliable, secure, clean water supplies
- Provide resiliency to climate and economic changes
- Minimize environmental pollution
- Promote long-term sustainability, equity, and prosperity
- Contribute to a livable city
- Protect human health
- Provide flood protection

We focused on watersheds and urban areas in the Willamette River Basin, OR to ask "How might integrated urban water management manifest across the landscape?" and, "To what extent can "One Water" approaches mitigate impacts of climate change and population growth?"



Late adopter: 2035



Late adopter: 2050

Early adopter scenario

The Oregon Urban Water Innovation Network

Integrated Water Future ca. 2060 Scenario Narrative

As defined by stakeholders advising the project, the central organizing principle of the Integrated Water Future is, "Water quality and quantity are managed at the watershed scale" in ways that anticipate and respond to challenges of future change. Policy objectives for urban development and the design and operation of water management systems include conservation and restoration of natural hydrological resources in the watershed to the maximum extent plausible.

Development	Watershed Protection	Conservation & Water Re-use	Green Infrastructure
5869 new dwellings; focus on high density development	Agency partnerships expand; riparian area & wetlands protected	Broad adoption of high efficiency practices; moderate graywater & stormwater reuse	Bioretention, swales, buffers, green blvds., green roofs; 55 ha GI in Sherwood Urban Reserve

Late adopter scenario

The Oregon Urban Water Innovation Network

Current Course ca. 2060 Scenario Narrative

The Late Adopter (OUWIN Current Course, CC) scenario assumes that current trends continue in population growth, climate change, and policy. Stakeholders advising the project defined the central organizing principle of the Current Course alternative future as: "Current regulatory regimes concerning water management and land use remain in effect." Existing trends in drinking water supply and quality, stormwater and wastewater facility development, monitoring and maintenance continue over time.

Development	Watershed Protection	Conservation & Water Re-use	Green Infrastructure
3620 new dwellings in urban reserve; mix of moderate & high density	Existing agency partnerships remain; high priority riparian areas protected	Moderate adoption of high efficiency practices; little water reuse	Bioretention areas, swales, moderate riparian buffers; 32 ha GI in Sherwood Urban Reserve

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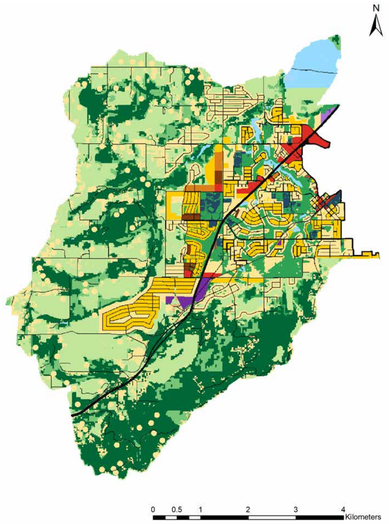
Examples of Innovations in Scenarios

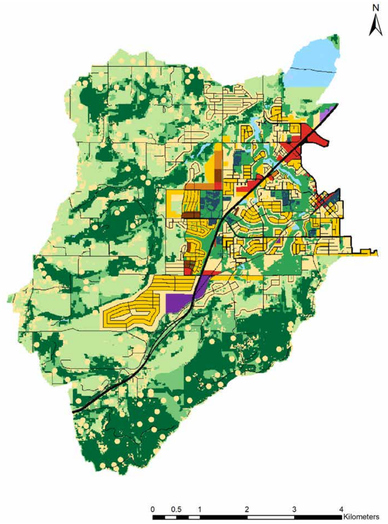
The Early Adopter scenario incorporates all ten key innovations identified as most relevant for our project. The Late Adopter future includes many of the same innovations employed to a lesser extent, while the Non-Adopter scenario illustrates the contrast between futures in which people embrace innovation and those that do not. Sustainable neighborhood pattern and design (#7) incorporates innovations #2-5, #8, #10 at the neighborhood scale. Resilient landscape infrastructure (#2) can be expressed at all scales, whereas #1, #6, and #9 are most relevant at the basin and watershed scale, though they also embody resilient landscape infrastructure.

Example: Green Boulevard Design

- Fewer, smaller parking spaces
- Road width decreases from 12' to 10'; median width increases and trees are planted every 25'



Non-adopter: 2035



Non-adopter: 2050

Non-adopter scenario

The Oregon Urban Water Innovation Network

Stressed Resources ca. 2060 Scenario Narrative

Stakeholders advising the project defined the central organizing principle of the SR future as a future in which options are limited by available resources and policies, a "run-to-fail" mindset; as a result, "Water treatment and conveyance infrastructure are stressed." Thus, drinking water supply and quality, stormwater and wastewater facility development, monitoring, and maintenance decline over time.

Development	Watershed Protection	Conservation & Water Re-use	Green Infrastructure
6107 new dwellings; lower density development	Minimal collaboration & little protection of riparian areas; focus on gray infrastructure	Moderate efficiency of water use; little water reuse	Minimal buffers and bioretention areas; 16 ha GI in Sherwood Urban Reserve

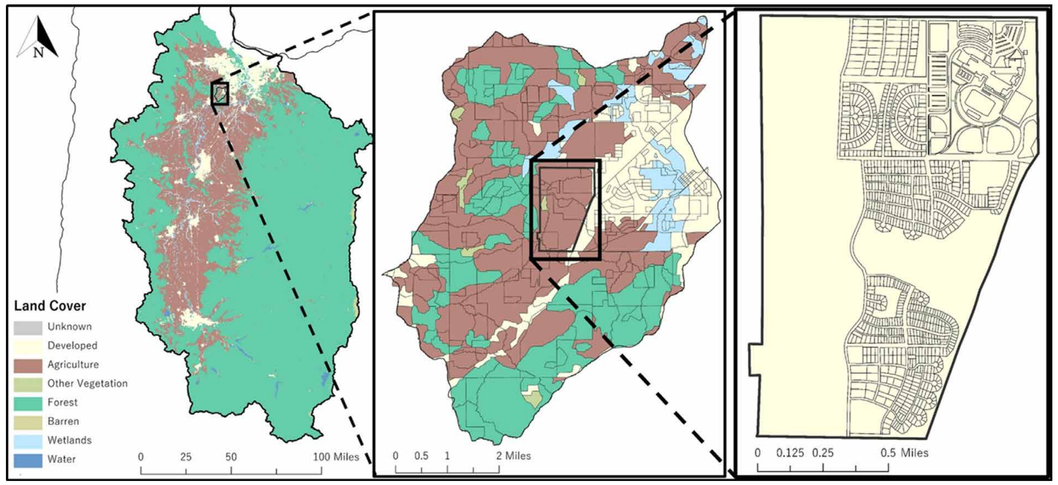
Multiple Scales

Impacts to different systems may be important at different scales. For example, increase in impervious area is important at the Neighborhood scale, less so at the Watershed and Basin scale. Impacts of increased forest fire frequency are likely to influence multiple systems and scales.

Findings to Date

The design and modeling of multiscale alternative futures helps stakeholders articulate and visualize how "One Water" management might look in their watershed and neighborhood.

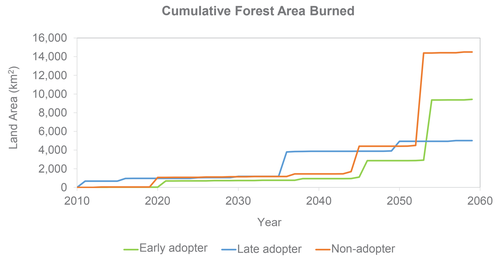
Anticipatory efforts can reduce pressures on urban water systems and the environment, but cannot eliminate the challenges created by climate change and population growth.



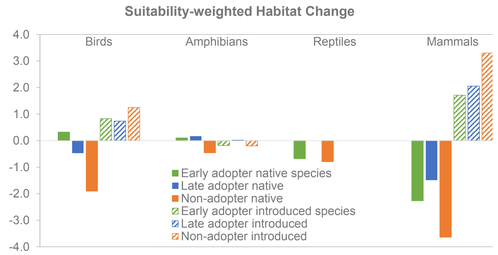
Protected Riparian Areas

Early adopter 2050	Late adopter 2050	Non-adopter 2050
All current class I riparian areas are maintained. Riparian corridors are preserved in newly developed areas, equaling 40% of these areas. Floodplain reconnection occurs in areas with appropriate topography and soils.	All current class I riparian areas are preserved. By 2060, a total of 1603 acres within the watershed are protected riparian zones, an increase of 538 acres over the 2010 equivalent of 1065 acres in protected riparian zones.	Development occurs in 10% of class I riparian areas. By 2060, a total of 962 acres within the watershed are protected riparian zone, a decrease of 103 acres relative to the 2010 equivalent of 1065 protected riparian zones.

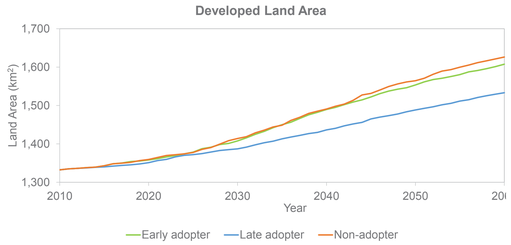
Agriculture and Forestry: Impacts of Fire



Natural Systems: Impacts to Vertebrate Biodiversity



Residential Systems: Impacts of Development



Participant Team Credits

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Portland State University: Sean Gordon

The OUWIN Stakeholder Advisory Committee

This project is supported by the US NSF Grant No.1444758

(SRN: Urban Water Innovation Network (U-WIN): Transitioning Toward Sustainable Urban Water Systems).

Photos: Mary Santelmann, George King, US Forest Service

Impact graphics for Development and Area Burned from: Willamette Water 2100. (2016). [Project Summary and Interactive Maps]. https://inr.oregonstate.edu/ww2100

Interaction and Tradeoffs between impacts among different systems